

# Eco-Industrial Districts – Background Paper

Seattle Eco-Industrial Initiative, June 2010

## **Sustainable Industrial Development: The Need for an Integrated Approach**

With the fast pace of change in the industrial sector, restructuring and redevelopment of traditional industrial areas and development of new industrial sites is a common phenomenon in many economies. Traditional industrial districts in urban areas are redesigned for commercial use and non-polluting industries, whereas polluting industry is transferred to rural areas, leaving brownfields and abandoned inner-city lots for redeveloped.

Despite more than 50 years of environmental protection efforts and development of production-integrated tools and concepts for pollution prevention, the environmental quality, and with it the quality of living, is still deteriorating. The mechanisms of Climate Change have been known since the times of the Club of Rome but have only been addressed during the last decade. Meanwhile other global environmental hazards are still awaiting the same attention: detoxification of production processes and products, the increasing volume of plastics in the environment, causing hazard to humans and wildlife alike, the social implications of global competition in developing countries, leading to more poverty and urbanization, and the increasing cost of energy and resources for production processes.

### **The Eco-Industrial Development Concept**

Since the middle of the 1990s industrial environmental protection has undergone a new stage of development aiming at integrating sector approaches in reducing environmental effects through modern management and production methods. *Eco-Industrial Development (EID)* is the result of an integration process that covers pollution prevention, industrial environmental management, cleaner production technologies and the (eco-) efficient use of natural resources. Combined with green design principles, sustainable planning of infrastructure and integrated production technologies Eco-Industrial Development provides the framework for sustainable industrial production.

The concept of Eco-Industrial Development (EID) is very attractive to a large number of established industrial clusters, industrial districts and industrial parks and also appeals to the development of new industrial sites in both industrialized and developing countries. However, up to now only a few initiatives in the USA, Europe and Asia have reached the point of turning ideas and master plans into action. If successful in the initial stage, EID initiatives are mostly limited to a few companies forming a symbiosis. Only few projects have so far achieved implementation of resource efficiency at a larger scale, mostly within the chemical and agro-based industries with large quantities of resources moving through industrial systems.

The concept of Eco-Industrial Parks and Clusters has developed in Europe and North America since the middle of the 1990s. The Industrial Symbiosis at Kalundborg has evolved since the 1970s, as have other clusters and industrial networks that exchange energy and by-products. However, industrial symbiosis has been practiced for more than 150 years since the beginning of the industrial revolution, only not on a systematic level nor under the banner of sustainable development.

Under the guidance of the US President's Council for Sustainable Development Eco-Industrial Development focused on redevelopment and rehabilitation of industrial sites, in North America named Industrial Parks. The Council provided initial funding for four Eco-Industrial Park (EIP) projects. Thus the term Eco-Industrial Park was coined in the USA, but can be applied equally to location based industrial systems as clusters, estates, and sub-regional networks.

Initially the Work and Environment Initiative at Cornell University facilitated a number of projects and formed a networking platform. Since then the Eco-Industrial Development Council (EIDC) and the Canadian Eco-Industrial Network (CEIN) have formed as a networking platform for projects, government agencies and consultants.

In Europe a number of networks and EIP projects have been started, mainly driven by universities and research institutions from the EU. In France, Germany, Italy, Norway and the United Kingdom, projects were initiated by industries or industrial networks. So far, no projects have emerged as fully developed Eco-Industrial Parks. In Asia the EIP concept has been received with great interest in many countries. A number of projects have emerged in recent years, with China, Korea and Thailand leading the development with several pilot EIP projects. Further EIP initiatives are in India, Indonesia and the Philippines. Most of these projects are donor-supported or initiated through US and EU agencies. In Australia and Japan industrial symbiosis has been implemented in a number of projects by industrial networks and local government around clusters of heavy industry.

### **Eco-Industrial Development and Competitiveness**

By becoming eco-industrial parks, eco-clusters, districts or networks, the adaptation of EID principles will enable resident industries to become more efficient and to reduce pollution through a variety of strategies. Some of the features that enable greater competitiveness include:

- Improved inter-company collaboration within the industrial cluster and within supply chains, enable synergy in environmental protection, community benefits, and competitive purchasing of resources.
- Shared services and facilities to lower costs of individual companies, especially small and medium scale enterprises; affordable access to cleaner production training and consultation is strategically important for SMEs.
- Company to company exchanges of material, energy, water and services enhances the efficiency of each unit of input.
- A cluster of resource recovery companies utilizes by-products that cannot be absorbed through direct company exchanges or recycling practices.
- A cluster of environmental technology and service companies supports companies within the greater cluster, park or district, especially SMEs, in improving product and process design, avoiding waste generation, and gaining higher efficiency.
- A management unit provides services for resource management, infrastructure, business services and knowledge-management to companies, utilities, the local community and local government.

### **Eco-Industrial Clusters and Districts**

As for industrial parks, the definition of industrial clusters and districts varies from country to country and is dependent on the history of industrial development and national policy and zoning regulation. The main differences between industrial sites are location specific rather than by naming or definition.

For developing eco-industrial systems, the main differences between industrial districts and industrial parks are the proximity and the availability or lack of management structures. The management aspect differentiates industrial districts from industrial parks, as the latter often have management of infrastructure and other basic industrial services, whereas industrial districts often lack these. In addition to management and services, the networking of enterprises and stakeholders is key to successful dissemination and implementation of sustainable structures. The eco-industrial system provides its services and know-how as center of excellence not only to the companies within the district or park, but to a larger community in the sub-region, to extended supplier networks and regional institutions. Eco-Industrial systems can thus become the center of a broader development on a regional scale.

Eco-Industrial Development is applied to three forms of development, 1) transformation of an existing industrial sites, 2) revitalization of previously used sites (brownfield re-

development), and 3) new site development (Greenfield sites). Revitalization can both include industrial sites and inner-city urban brownfield redevelopment. Eco-industrial development concepts are also adapted to the redevelopment of military facilities into both industrial and mixed urban-commercial complexes.

Planning of new eco-industrial clusters or redeveloping existing sites both has potential pitfalls for the planner. Existing industrial clusters have the companies for potential synergies, but often the interaction (community) between the companies is not developed, making it difficult to get to know companies and their potential in detail. Whereas industrial parks in Asia often have a management unit, industrial clusters have no management or only an association. For clusters local authorities have to invest time and resources in community development among the companies and to analyze their production structure for potential synergies.

New developments have many theoretical opportunities for industrial symbiosis, since companies can be matched according to theory, but to identify these companies and turn them into potential investors is a major task. New developments obviously also lack the community of companies, which will grow as new investors join the project.

### **Eco-Industrial Development: A Definition**

**Eco-Industrial Development** is an integrated system of shared resources (material, knowledge-based, social, etc,) among industries, businesses, and the local community that lead to economic gains, enhanced environmental quality, and improved human resources for the business and local community. (President's Council on Sustainable Development).

**Eco-Industrial Cluster, Eco-Industrial Park, Eco-Industrial District** is a community of manufacturing and service businesses located together on a common property or adjacent properties within the same location. Members seek enhanced environmental, economic, and social performance through collaboration in managing environmental and resource issues. The members of the site have a common objective about the site development and engage in specific activities to reach that objective.

**Eco-Industrial Network** is a set of companies in a region seeking to improve their environmental, social, and economic performance through collaboration. An EIN may include industrial parks and their companies and be supported by public sector organizations. An Eco-Industrial Network provides the context in which industrial parks and stand-alone factories can practice Eco-Industrial Development. It allows them to achieve the necessary scale of operation often required to optimize use of resources and create synergies between its members.

**Industrial Ecology** is the science applied for Eco-Industrial Development. Industrial Ecology examines the impact of industry and technology and associated changes in society and the economy on the biophysical environment. It examines local, regional and global uses and flows of materials and energy in products, processes, industrial sectors and economies and focuses on the potential role of industry in reducing environmental burdens throughout the product life cycle.

**Industrial Symbiosis** describes the co-existence between diverse organisms in which each may benefit from the other. Industrial Symbiosis was first applied for the industrial co-operation that has evolved between companies and the municipality of Kalundborg in Denmark, all of which exploit each other's residual or by-products.

### **Strategies for eco-industrial site development**

**Anchor tenant.** This involves having a large industrial user, often a power plant, sugar refinery or other types of operation with large-scale material flows, that the industrial park will be developed around.

**Materials or By-product exchange.** This can occur either in an eco-industrial park or in a regional network of businesses, including industrial parks. This involves using one industry's waste or "by-products" as another industry's raw materials.

**Resource Recovery System** is an expanded concept of the by-product exchange and includes all forms of material and product recovery in an industrial complex (waste management, by-product exchange, recycling and remanufacturing).

**Energy Cluster.** Involves maximizing energy efficiency through design or rehabilitation, co-generation, and energy cascading in a cluster of companies. It can also include the utilization of renewable energy.

**Thematic District.** A number of districts and industrial parks focus on co-locating a specific type of industry. Selecting an industry does not provide additional opportunities for synergies as often as mixed sector industrial parks. Industries closely related by sector, however, often have existing networks and business relationships or common interests that foster community development. Examples of such thematic parks are:

**Agriculture-based Eco-Industrial Clusters** (or Agro-EIP): provides support for sustainable farming and food processing and includes several basic types of firms and agencies which may be recruited as tenants:

**Chemical EIP:** The chemical industry uses co-location of production units and upstream-downstream synergies as their core business. Improvements in individual facilities and inter-facility synergies can be achieved through 'green chemistry' innovations in product and process design and co-locating more companies. Modern chemical development usually happens in Chemical Parks. The links between the companies are not EIP structures as such.

**Sector-specific EIP / Cluster (Textile, Electronics etc.):** In Asia a number of regions have historical industrial districts with an agglomeration of sector industries, often as industrial clusters, but also as industrial parks. Companies located there usually have similar problems and less potential for synergies, but strong links between companies (associations) can stimulate joint problem solving and innovation concepts.

**Resource Recovery Park / Cluster:** Companies in recycling, reuse, remanufacturing, niche collection of materials, and manufacturing from recovered materials form a cluster with good synergies among them.

**Environmental Technology Parks:** The concept focuses on the promotion of environmental technology industries. Aside from possible innovation synergies, their co-location does not necessarily provide any benefit in industrial symbiosis. Many environmental technology companies produce like ordinary manufacturing businesses.

## Areas of eco-industrial development (EID)

### Materials

- ☐ Common purchasing
- ☐ Customer/supplier relations
- ☐ By-product connections
- ☐ Create markets for new material

### Transportation

- ☐ Ride-share and vans
- ☐ Integrated logistics
- ☐ Shared shipping
- ☐ Common vehicle maintenance
- ☐ Intra-park transportation

### Information and Communications Systems

- ☐ Internal communications systems
- ☐ External information exchange
- ☐ Monitoring & feedback systems
- ☐ Computer compatibility
- ☐ Joint MIS systems for Park Mgt

### Energy

- ☐ High performance buildings
- ☐ Energy auditing
- ☐ Cogeneration
- ☐ Spin-off energy firms
- ☐ Alternative fuels

### Marketing

- ☐ Green labeling
- ☐ Accessing green markets
- ☐ Joint promotions (advertising/trade shows)
- ☐ Recruiting new companies

### Environment, Health & Safety

- ☐ Accident prevention
- ☐ Emergency preparedness, prevention & response systems
- ☐ Waste minimization
- ☐ Multimedia planning
- ☐ Shared environ. Info. systems

### Human Resources

- ☐ Recruiting & benefit packages
- ☐ Wellness programs
- ☐ Common needs (payroll, security maintenance, training)
- ☐ Flexible employee assignment

### Production Processes

- ☐ CP & pollution prevention
- ☐ Scrap reduction and reuse
- ☐ Production design
- ☐ Common subcontractors/equipment
- ☐ Technology sharing & integration

### Quality of Life / Community Connections

- ☐ Integrating work & recreation
- ☐ Cooperative education programs
- ☐ Volunteer / community programs
- ☐ Involvement in regional planning

### Resource Recovery

- ☐ Collection / hauling
- ☐ Recycling
- ☐ Re-refining (chemicals & oils)
- ☐ Re-manufacturing
- ☐ Composting

### Product Lifecycle

- ☐ Product take-back
- ☐ Design for Environment
- ☐ Remanufacturing
- ☐ Dematerialization
- ☐ Alternative packaging

*Based on  
Ed Cohen-Rosenthal  
2000 & 2002*

## Potential Benefits of Eco-Industrial Development

### Communities

Expanded local business opportunities  
Improved tax base  
Community pride  
Reduced waste disposal costs  
Improved environment and habitat  
Recruitment of higher quality companies  
Improved employees & community health  
Partnership with business  
Minimized impact on infrastructure  
Reduction in disposal costs  
Enhanced quality of life near EID  
Improved aesthetics  
Good jobs

### Environment

Continuous environmental improvement  
Reduced pollution  
Innovative environmental solutions  
Increased protection of natural ecosystems  
More efficient use of natural resources  
Protection and preservation of natural habitat  
Reduction of environmental liability

### Business

Higher profitability  
Enhanced market image  
High performance workplaces  
Improved efficiency  
Access to financing  
Regulatory flexibility  
Higher value for developers  
Reduction of operating costs (i.e. energy, materials)  
Income from sale of by-products  
Improved public image  
Increased employee productivity

## **Best Practice: Integrated Urban-Industrial Development at Devens Sustainable Community**

Devens, a recognized sustainable community near Boston, is one of the successful prototype developments of an Eco-Industrial Park. The industrial development is embedded in a sustainable community concept, thus providing a best practice approach for integrated urban-industrial development.

Devens is located on a former army base that has been redeveloped by the State of Massachusetts as a brownfield site. The mainly industrial community is located on 4,400 acres of the former Fort Devens army base which closed in 1996. The base closure resulted in the loss of 3,000 civilian jobs. The need for sustainable re-development of the site was expressed by neighboring communities who wanted to create new jobs without the negative environmental effects of the former army base. A comprehensive redevelopment plan with intensive community participation defined Devens as a Sustainable Community.

Open for business since 1996, the park is home to more than 75 businesses employing a total of 4,000 people. In 2000, the Devens Enterprise Commission (DEC) conducted a survey with existing business to establish an Eco-Industrial Park concept. A potential for the application of industrial ecology principles into the operation of industrial activity at Devens was identified. The creation of an eco-industrial park at Devens includes both 1) existing industrial activity will be altered to fit into the industrial ecosystem concept, and 2) new industrial development that will invest in Devens will be fit into this industrial ecosystem approach. During the permitting process for new companies or expansion projects, DEC works intensively with investors to ensure the best possible solution for integrating EID principles into the development. Some businesses have located at Devens especially due to the sustainable development plan and respective services provided by the Devens Enterprise Commission (DEC).

Another concern of the sustainable development concept was to assist companies in continuously improving their performance once the business was developed. After consulting with the business sector about their potential needs, DEC established the 'EcoStar' program in close cooperation with enterprises and local communities. This program provides technical support and public recognition to businesses achieving a set of mandatory and voluntary environmental standards. The Eco-Star standards also support the networking between companies based on Industrial Ecology principles. Besides creating synergies in by-product exchange, recycling and waste management activities, a major networking aspect is the sharing of know-how on environmental issues, joint use of services (logistics, storage) and joint training programs for employees. These activities not only have positive environmental effects but mostly lead to cost reduction and better business environment. The Eco-Star program has now been integrated into a new Eco-Efficiency Center (Eco-Center), that is being developed in cooperation with the Eco-Efficiency Center at Burnside, Halifax (see end of the article for a description).

The community attracts major industrial and commercial investment through its eco-industrial development strategy. In 2007, Devens attracted a 1.1 Billion US \$ investment from Bristol-Myers Squibb, mainly due to its sustainable development strategy and one-stop-permitting process that critically reduces the permitting process, thus reducing development cost and investment risk. Devens is a north-american leader in Eco-Industrial Development. Aside from industrial and commercial development, Devens features green housing developments, a sustainable golf course, recreation areas and protected wetlands.

The synergy links also extend into the four surrounding towns, where over 50 manufacturing companies are located. These facilities have material flows and services that are being connected into the greater Devens industrial ecosystem.

Devens was designed to have six separate industrial clusters / districts. The areas are connected through a road network and a greenway network. The companies are located in close proximity to one another and in some cases co-located to enable synergies and cost-effective material flows between them. EID components include material exchange programs, joint services (e.g. landscaping), green building standards, promotion of pollution pre-

vention beyond standards, joint logistics, promotion of public transport for employees, close-to-work housing development to reduce commuting, among others.